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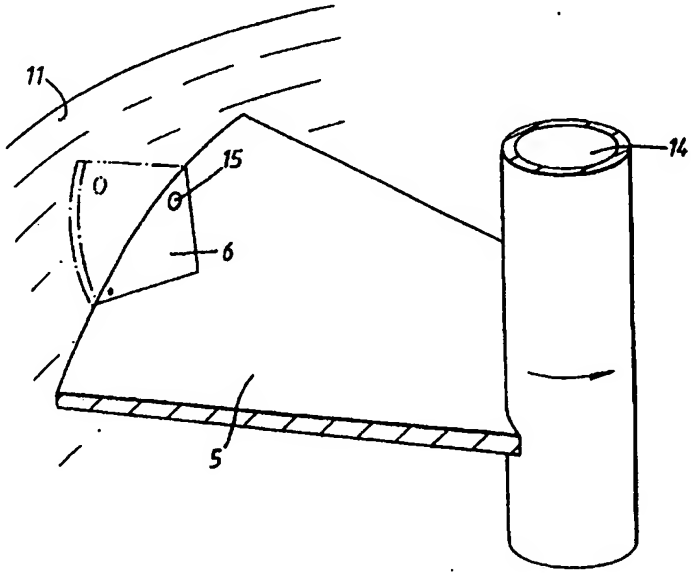

(57) Abstract

A continuous flight piling auger (2) including a retractable element (6) which may be extended beyond the circumference of the flight (5) of the auger (2). In use, the auger (2) is rotated and allowed to penetrate the ground so as to define a bore hole. The retractable element (6) is extended so as to cut or displace a region of soil (11) surrounding the auger (2) thereby forming a void, and the auger (2) is withdrawn while concrete is supplied to the tip (3) of the auger (2) so as to fill the bore hole and the void. The resulting pile (7, 9) has an enhanced bearing capacity due to its greater diameter in the regions (8, 10) where the soil was cut or displaced by the retractable element (6).

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BEARING CAPACITY ENHANCEMENT FOR PILING APPLICATIONS

The present invention relates to a tool for enhancing the bearing capacity of a pile, in particular but not exclusively the bearing capacity of a rotary-bored pile and/or a pile formed by a continuous flight auger.

It is well-known in the construction industry to enhance the bearing capacity of a pile by using an under-reamer to enlarge the diameter of a portion of the shaft in which the pile is to be formed. By enlarging the diameter of this portion, the end bearing capacity is increased, and accordingly it is possible to reduce the length of the pile, since less shaft friction is required to bear a given load. This is described, for example, in U.K. patent no. 2 222 621 granted to the present applicant. However, this technique requires the use of a special tool which must be lowered into the bore hole after the bore hole has been formed, which increases installation time and may risk disturbing the walls of the bore hole, thereby reducing the integrity of the completed pile.

According to a first aspect of the present invention, there is provided a continuous flight piling auger, wherein the auger includes at least one retractable element which may be extended so as to project beyond the circumference of the flight or flights of the auger, characterised in that the at least one retractable element is located in a circumferential part of the auger flight or flights.

According to a second aspect of the present invention, there is provided a method of installing a pile using a continuous flight auger, wherein:

i) the auger is rotated and allowed to penetrate the ground to a predetermined depth so as to define a

bore hole;

ii) a retractable element located on a circumferential part of the auger flight or flights is extended so as to project beyond the circumference of the flight or flights of the auger and thereby to cut or displace a region of soil surrounding the rotating auger so as to form a void; and

iii) the auger is withdrawn while concrete is supplied to the tip of the auger so as to fill the bore hole and the void.

The continuous flight auger of the present invention can be used in the conventional manner to form a bore hole in cohesive or non-cohesive material. Advantageously, when the at least one retractable element is in its retracted position, it offers little or no resistance during penetration of the auger. When the auger has reached a predetermined depth, the at least one retractable element may be extended beyond the circumference of the auger flight or flights so as to cut into or displace a portion of the material surrounding the auger as the auger continues to rotate. The at least one retractable element may then be returned to a position within the circumference of the auger flight or flights. During retraction, material which has been cut by the at least one element may be drawn onto the auger flight or flights for removal. Alternatively, where material has been displaced by the at least one retractable element, there is no need to remove any additional material. The auger may then be withdrawn from the ground while concrete or the like is pumped into the bore hole, e.g. through the centre of the auger, so as to form a pile.

In some embodiments, an additional concrete delivery system may be associated with the at least one retractable element so as to supply concrete directly to the void left by the cut or displaced material.

This can help to avoid swelling or collapse of the void, and is particularly useful when a number of cuts or displacements are made during penetration of the auger.

Alternatively, where the at least one retractable element is located at or near the bottom of the auger, the auger may be rotated during withdrawal and the at least one retractable element may be operated at so as make cuts or displacements at predetermined positions, the voids being filled with concrete by means of the main concrete supply.

The at least one retractable element is located on the circumference of the auger flight or flights, may extend across two or more flights, and may be located at any point along the length of the auger.

In one preferred embodiment of the present invention, there is provided a single retractable element which is shaped so as to displace material when it is in its extended position. The element is advantageously located at the bottom of the auger, but may be located at other positions if it has an associated additional concrete delivery system. The element is kept in a retracted position during penetration of the auger. Upon withdrawal, the element is extended and the auger rotated. As the auger is withdrawn and concrete is pumped to the tip of the auger so as to form a pile in the bore hole, the element will form a helical void in the surrounding material and the void, as well as the main shaft of the bore hole, will be filled with concrete.

By way of the present invention, it is possible significantly to reduce the length of a pile required to bear a given load. For example, a conventional pile of 600mm diameter and 27m in length will have a shaft friction in a cohesive clay soil of 4165kN and an end bearing of 787kN, giving a total capacity of 4952kN. A

similar pile 20m in length will have a shaft friction of 2360kN and an end bearing of 606kN, giving a total capacity of 2966kN. In contrast, a 20m pile of normal diameter 600mm but with an enhanced diameter of 1200mm in a region 2m above its base will theoretically have a shaft friction of 2360kN and an end bearing of 1661kN plus 606kN, giving a total bearing capacity of 4627kN. It has been found in practice that the shaft friction is 3225kN and the end bearing 1820kN, giving a total of 5045kN. By using the present invention, therefore, much time and material can be saved when installing a series of piles.

For a better understanding of the present invention, and to show how it may be carried into effect, reference shall now be made, by way of example, to the accompanying drawings, in which:

FIGURE 1 shows a piling rig fitted with a continuous flight auger;

FIGURE 2 shows a detail of an auger flight.

FIGURE 3 shows the profile of the bottom of a pile installed by one embodiment of the present invention; and

FIGURE 4 shows the profile of the bottom of a pile installed by another embodiment of the present invention.

Figure 1 shows a piling rig 1 upon which a continuous flight auger 2 is mounted. Concrete can be supplied to the tip 3 of the auger 2 by way of a pipeline 4. The auger 2 includes a flight 5 which, as well as helping the auger 2 to penetrate the ground, also serves to remove soil from the bore hole which is to be formed. A retractable element 6, shown in more detail in Figure 2, is provided at the edge of the flight 5 near the bottom of the auger 2. This retractable element 6 is movable between its retracted position and an extended position, indicated by way of

broken lines in Figure 2, in which position it projects beyond the circumference of the flight 5 of the auger 2.

In use, the auger 2 is rotated and allowed to penetrate the ground to a predetermined depth. Normally, the rate of rotation and the rate of penetration are controlled so that there is some degree of shearing between the soil on the auger flight 5 and the soil 11 surrounding the auger 2. When the auger 2 has reached a predetermined depth, the retractable element 6 is moved to its extended position (shown by broken lines in Figure 2) and the auger is rotated. In some embodiments, the soil 11 surrounding the auger 2 at this point is thereby displaced so as to create a generally annular void. Alternatively, the retractable element 6 may be shaped and positioned to as to cut into the soil upon extension, the cut soil then being carried away up the auger flight 5 when the element 6 is retracted.

Once the void has been created, the element 6 is retracted and the auger 2 is withdrawn from the ground. As the auger 2 is withdrawn, concrete is pumped to the tip 3 of the auger 2 by way of pipeline 4 and the hollow stem 14 of the auger 2. This concrete fills up the bore hole, including the void, so as to form a pile 7, the bottom part of which is shown in profile in Figure 3. In some embodiments of the present invention, concrete may be delivered directly to the void by way of an opening 15 located on the retractable element 6 and communicating with the hollow stem 14 of the auger 2. This can help to avoid premature collapse of the void.

The shape of the pile 7 in the region 8 of enhanced diameter is dependent upon the particular retractable element used. Either or both the lower surface 12 as and the upper surface 13 may be straight,

concave or convex, or any other shape. In the particular embodiment shown, the region 8 is 2m from the base of the pile 7.

An alternative pile 9 is shown in profile in Figure 4. This pile 9 has a projection 10 which describes a helix about the axis of the pile, and acts as a region of enhanced diameter. The projection 10 is formed by progressing the auger 2 to the required depth, moving the element 6 into its extended position, and rotating the auger 2 as it is withdrawn. Concrete is pumped to the tip 3 of the auger during withdrawal so as to fill the bore hole and also to fill the surrounding helical void as it is being created by way of the displacement of soil by the element 6.

CLAIMS:

1. A continuous flight piling auger, wherein the auger includes at least one retractable element which may be extended so as to project beyond the circumference of the flight or flights of the auger, characterised in that the at least one retractable element is located in a circumferential part of the auger flight or flights.

2. An auger as claimed in claim 1, wherein the at least one retractable element is operable to discharge concrete.

3. An auger as claimed in claim 1 or 2, wherein the at least one retractable element extends across two or more flights.

4. An auger as claimed in any one of the preceding claims, wherein the auger comprises a hollow stem through which concrete may be delivered.

5. An auger as claimed in any one of the preceding claims, wherein the at least one retractable element includes an opening which communicates with the hollow stem of the auger and through which concrete may be delivered.

6. An auger as claimed in any one of the preceding claims, wherein the at least one retractable element is located at or near the tip of the auger.

7. An auger as claimed in any one of claims 1 to 6, wherein the at least one retractable element is located away from the tip of the auger.

8. A method of installing a pile using a continuous flight auger, wherein:

i) the auger is rotated and allowed to penetrate the ground to a predetermined depth so as to define a bore hole;

ii) a retractable element located on a circumferential part of the auger flight or flights is extended so as to project beyond the circumference of

the flight or flights of the auger and thereby to cut or displace a region of soil surrounding the rotating auger so as to form a void; and

iii) the auger is withdrawn while concrete is supplied to the tip of the auger so as to fill the bore hole and the void.

9. A method according to claim 8, wherein concrete is supplied, by way of the retractable element, to the void left by the cut or displaced material.

10. A method according to claim 8 or 9, wherein the auger is rotated during withdrawal with the retractable element extended.

11. A method according to claim 8 or 9, wherein the retractable element is retracted before withdrawal of the auger.

12. A method according to claim 11, wherein the auger is not rotated during withdrawal.

13. A method according to any one of claims 8 to 12, wherein soil is cut by the retractable element when extended during rotation of the auger and is carried onto the flight or flights of the auger.

14. A method according to any one of claims 8 to 12, wherein soil is displaced by the retractable element when extended during rotation of the auger and is compacted into the ground surrounding the auger.

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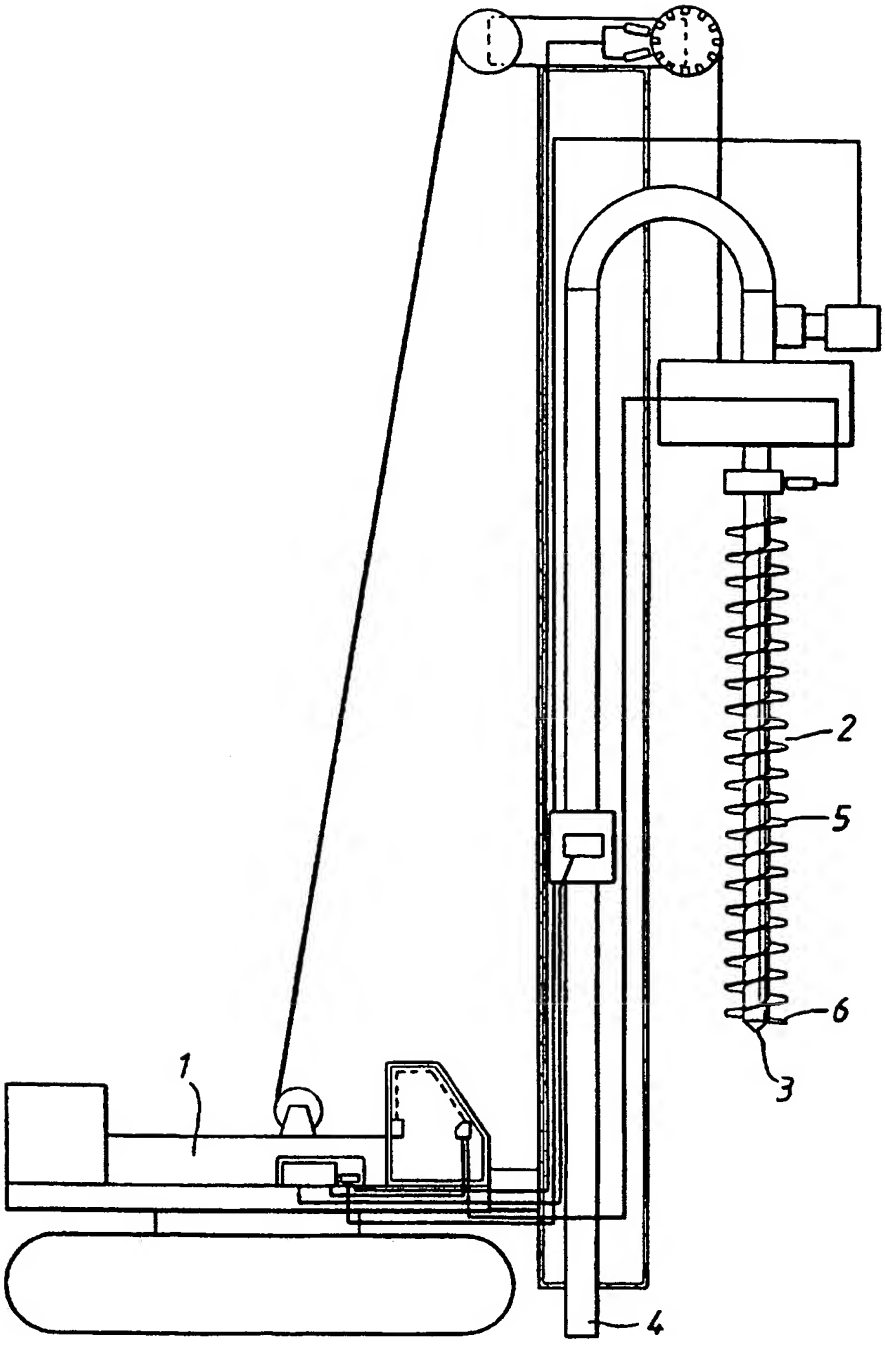

Fig.1

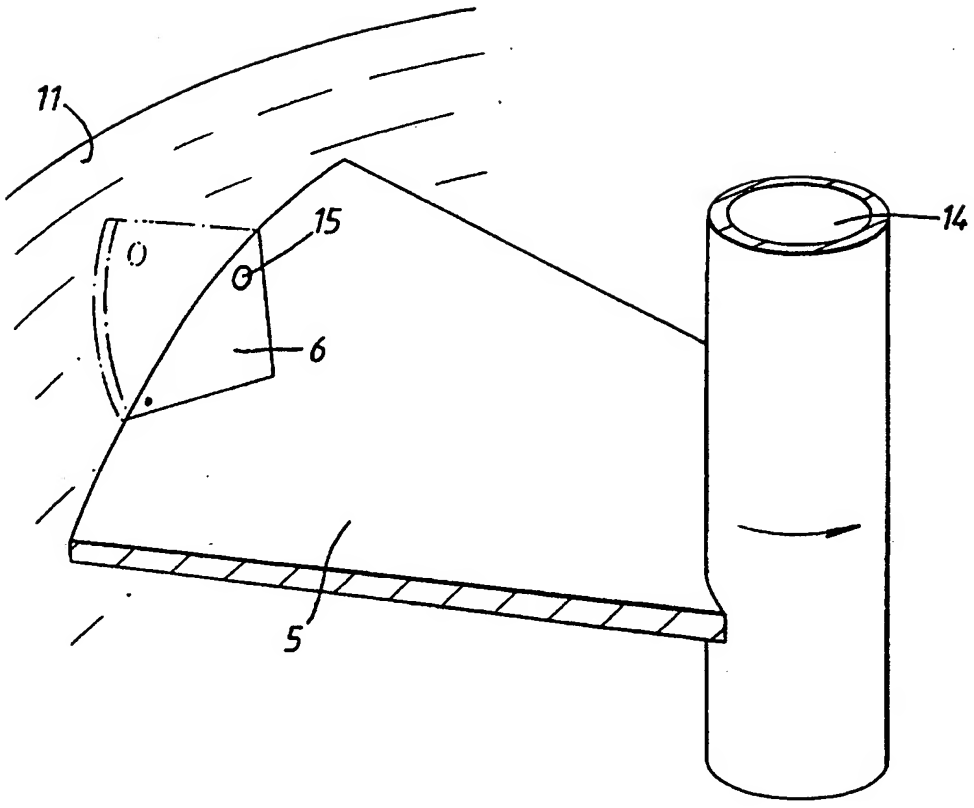

Fig. 2

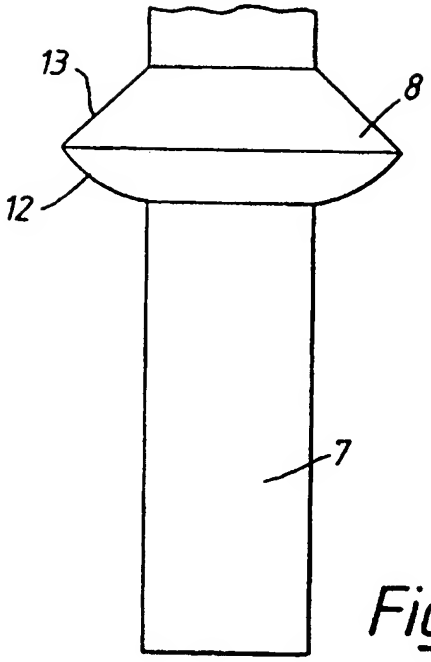

Fig.3

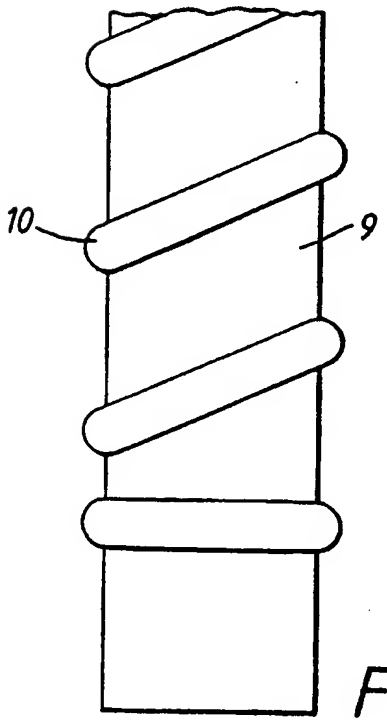

Fig.4

INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/GB 97/02558

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E02D5/36 E02D5/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 E02D

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	GB 1 391 110 A (TURZILLO L A) 16 April 1975 see the whole document	1,4,6,8, 10,11,14 3,7,12, 13
X A	AU 586 947 B (CATAWA PTY LTD) 27 July 1989 see page 5, line 2 - page 7, line 24; figures 1-4	1,4,6,8, 10,11,13 3,7
X	PATENT ABSTRACTS OF JAPAN vol. 14, no. 81 (M-0935), 15 February 1990 & JP 01 295913 A (MACHINAGA ASANO PAUL KK), 29 November 1989, see abstract	1,4,6,8

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 1391110 A	16-04-75	NONE	
AU 586947 B	27-07-89	AU 1284888 A	08-09-88